



**US Army Corps  
of Engineers®**



## **Limited Visual Dam Safety Inspections**

**OA00001**

**Nuuanu Dam No. 4**

**Oahu, Hawaii**

**Prepared by:**

**U.S. ARMY CORPS OF ENGINEERS  
HONOLULU DISTRICT**

**STATE OF HAWAII  
DEPARTMENT OF LAND AND NATURAL RESOURCES**

**May 2006**

Dam ID: OA-0001

Name: Nuuanu Dam No. 4

Limited Visual Dam Safety Inspection Conducted on: 03 April 2006

**I. Purpose:**

Due to disaster occurrences of periodic heavy rains and flooding, which has caused extensive damage to property and loss of lives, the Governor has issued a State of Emergency Proclamation extending from February 20, 2006 to April 9, 2006. In light of the tragic failure of the Kaloko dam on Kauai and the continued forecast of heavy rains, emergency inspections of all regulated dams in all counties are being undertaken.

These inspections are for the purpose of determining if any of the regulated dams and reservoirs in the City and County of Honolulu, Maui County or Hawaii County, are suspect for immediate concern to the downstream area under the prolonged conditions of heavy rain showers.

**II. Authority**

Inspections were authorized under the Hawaii Dam Safety Act of 1987, Chapter 179D "Dams and Reservoirs" of Hawaii Revised Statutes, and Title 13, Subtitle 7, Chapter 190, "Dams and Reservoirs" of the Hawaii Administrative Rules.

These inspections were conducted under joint agreements of the U.S. Army Corps of Engineers (ACE), the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), and the State of Hawaii. The Memorandum of Agreement with the U.S. Army Corps of Engineers is entered into pursuant to 10 U.S.C. § 3036(d)(2), and the Intergovernmental Cooperation Act (31 U.S.C. §6505), and established via support agreement number DL-06-01.

**III. Scope**

Visual inspection was performed on parts of the embankment and appurtenant works readily available and visible for inspection by the inspection team at the time of the inspection. Such parts and appurtenant works included the upstream slope, crest, downstream slope, abutments and toes, outlet works, and spillway.

On the date of this limited visual inspection, there may or may not have appeared to be any immediate threat to the safety of the dam, however no assurance can be made regarding the dam's condition after this date. Subsequent adverse weather and other factors may affect the dam's condition.

**IV. Limitations of Findings and Recommendations**

The inspection is based only on visible features/areas of the dam on the day of inspection. The inspection does not entail detailed stability, hydrologic, hydraulic, or seismic investigations. This inspection is not a formal phase I or phase II dam safety inspection and does not include a review or evaluation from each specialist of an inspection team, such as a geologists, civil, geotechnical, structural, or hydraulics engineer. The owner should verify the findings of this report and take corrective actions. The owner may submit to the State alternative corrective actions that are certified by a licensed professional engineer in the State of Hawaii experienced in the design and construction of dams. This inspection does not relieve the owner/operator from their responsibility to conduct routine inspections, maintenance, repairs, modifications, monitoring, documentation, and/or investigative studies.

**V. Inspection Team**

Organization

U.S. Army Corps of Engineers  
 State of Hawaii, Dept. of Land and Natural Resources  
 National Resource Conservation Service

Name

Mr. Troy Cosgrove  
 Mr. Hiram Young  
 Mr. Doug Toews

**VI. Owner's Representatives Present**

Mr. Darrel Wong, Board of Water Supply

**VII. Summary Report Team**

Organization

U.S. Army Corps of Engineers  
  
 State of Hawaii, Dept. of Land and Natural Resources

Name

Mr. Derek Chow  
 Mr. Joseph Koester  
 Ms. Denise Manuel  
 Mr. Edwin Matsuda

**VIII. Dam Type**

The dam is an earthen embankment.

**IX. Dam Classification**

The current hazard classification of this dam is: High  
 Based on available data, this classification is believed to still be applicable.

Hazard Potential Classification based on the following:

Category	Loss of Life	Economic Loss
Low	None Expected	Minimal (undeveloped to occasional structures or agriculture)
Significant	Few (No Urban development and no more than a small number of inhabitable structures)	Appreciable (Notable agriculture, industry or structures)
High	More than a few	Extensive community, industry or agriculture.

Based on inventoried storage and height data, the size classification of the dam is:  
 Intermediate

Size Classification based on the following:

Category	Storage (Acre-Feet)	Height (feet)
Small	< 1000	< 40
Intermediate	> 1000 and < 50,000	> 40 and < 100
Large	> 50,000	> 100

**X. Summary of Inspection:**

Condition Rating Criteria: The conditional terms in this report are used to generally describe the conditions below. Inspections, monitoring, and additional investigations are considered to be incidental to all condition ratings.

Satisfactory	Expected to fulfill intended function.
Fair	Expected to fulfill intended function, but maintenance is recommended.
Poor	May not fulfill intended function; maintenance or repairs are necessary.
Unsatisfactory	Is not expected to fulfill intended function; repair, replacement, or modification is necessary.
Unknown	Not visible, not accessible, not inspected, or unable to determine the condition rating based on the observation taken.

**A. General appearance:**

The reservoir and dam features were not easily recognizable. The dam was overgrown with vegetation. The dam appears to have a sizeable drainage area.

Modifications / Improvements: There were no signs of any recent modifications.

Based on topography, offsite drainage is expected from a significant drainage area.

Based on staff personnel. This reservoir has no incident history.

**Findings and Corrective Actions:**

- a. The Owner shall maintain documentations including Construction plans, specifications, improvements, modifications, Operations and Maintenance Manuals and routine inspection logs for this dam facility.
- b. An Emergency Action Plan (EAP) is on file with the department, submit any updates as applicable.
- c. Routine inspection logs were not inspected.
- d. Dam owners shall provide for routine inspection of the dam.
- e. The dam did not appear to be maintained on a regular basis.
- f. Access to site appears to be satisfactory.
- g. Provide a detailed narrative of the incident, responses taken, and any damages incurred. Dam owners are required to promptly advise the department of any sudden or unprecedented flood or unusual or alarming circumstance or occurrences that may adversely affect the dam or reservoir.
- h. Submit current Operations and Maintenance Manual or Procedures for this dam / reservoir facility.
- i. Submit Site or Facility Map of this Dam which identifies the location of major features including outlet works controls and conduits.



- j. Emergency Alarms / Monitors: There were no alarms or monitors observed on this reservoir.
- k. Power / Communication: There were no communication systems observed on this reservoir. There were no utility or power poles visible nearby.

**B. Access / Security:**

Access to the dam was accomplished via a County roadway.  
Access does not require a 4 wheel drive vehicle.

Security issues. Access to the dam is via a locked gate.

**C. Inflow Works:**

This reservoir is feed by surface runoff and no intakes were noted.

**D. Reservoir**

The reservoir level during the inspection was 40.7 ft per an electric measuring tape. A staff gage was not observed. However, an electric tape in the stilling well of the tower is used to monitor the reservoir level.

According to staff personnel, the reservoir is normally held at 30 ft based on the lowest operating gate of the intake tower.

Typically the spillway is not flowing.

Typically the reservoir is kept open and is at normal the normal level.

Findings and Corrective Actions:

- a. The reservoir was not inspected.
- b. A staff gage was not observed at the reservoir. Provide some method of quantifying the water level within the reservoir as a back-up to the electric tape.

**E. Upstream Slope (Poor)**

The upstream slope varied in slope and was roughly 1V to 4H (Vertical / Horizontal). A fitted rip rap rock slope protection was observed. Vegetation was observed growing between the rocks.

Erosions were not observed, the slope was no t entirely visible.

Cracks were not observed; the slope was not entirely visible.

Sinkholes were not observed, the slope was not entirely visible.

The upstream slope was not entirely visible due to heavy woody and grass vegetation.

Findings and Corrective Actions:

- a. The upstream slope was not inspected.
- b. The upstream slope was not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.
- c. Tree(s) were observed on the dam embankment. Trees have been identified as the probably cause of piping failures, and can possibly cause severe damage to the embankment if they are uprooted during a high winds. Corrective action is

required to remove the tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2" diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of licensed geotechnical or structural engineer. Routinely monitor the damaged area for signs of settlement and seepage.

- d. Monitor downstream piezometers at a higher frequency during higher pools.

**F. Crest: (Fair)**

The dam crest was approximately 20 feet wide.

There was a dirt access road on top of the crest the appeared to be well utilized.

There was high vegetation on either edge of the crest.

Vegetation was observed on the edges of the crest. These were primarily small woody vegetation and high grass.

**Findings and Corrective Actions:**

- a. The dam crest appeared to be in fair to poor condition and requires corrective action.
- b. Access along the crest was satisfactory.
- c. Portions of the crest were not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.
- d. Tree(s) were observed along the dam crest. Trees have been identified as the probably cause of piping failures, and can possibly cause severe damage to the embankment if they are uprooted during a high winds. Corrective action is required to remove the tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2" diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of licensed geotechnical or structural engineer. Routinely monitor the damaged area for signs of settlement and seepage.

**G. Downstream Slope: (Poor)**

The downstream slope was in poor condition and not visible due to heavy vegetation.

The slope was, around a 1 on 2 (V / H).

There was limited access to the downstream slope via a foot path.

There was some riprap observed on the downstream slope near the toe of slope.

Erosion was not observed on the downstream slope, however the slope was not entirely visible.

Sinkholes were not observed on the downstream slope, however the slope was not entirely visible.

Vegetation was observed on the downstream slope. The majority of the vegetation was woody trees ranging from 6: to the greater than 2 feet in diameter.

Seepage was not observed on the downstream slope, however the slope was not entirely visible.

**Findings and Corrective Actions:**

- a. The downstream slope appeared to be in fair to poor condition and requires corrective action.

- b. The down stream slope was not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.
- c. Tree(s) were observed on the downstream slope. Trees have been identified as the probably cause of piping failures, and can possibly cause severe damage to the embankment if they are uprooted during a high winds. Corrective action is required to remove the tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2" diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of licensed geotechnical or structural engineer. Routinely monitor the damaged area for signs of settlement and seepage.
- d. Near the downstream slope the slope steepens to 1 on 1. This may be a stability berm and further study maybe required to verify slope stability.

**H. Abutments / Toe: (Poor)**

The abutments and toe were not entirely visible or identifiable due to heavy vegetative growth.

Erosion along the abutment or toe was not entirely visible or identifiable due to heavy vegetative growth.

Cracks in either direction were not observed, however the toe was not entirely visible.

There was heavy vegetation along the abutments and toe locations.

Areas were noted along the toe that could be possible seepage spots. These locations were observed near the base of the center stability berm, left side and also the left side closer to the outlet channel. The water that was seeping appeared to be moving relatively slow and seemed to be clear.

**Findings and Corrective Actions:**

- a. The abutments/toe were not inspected. (Not fully inspected due to heavy vegetation)
- b. The abutments/toe appeared to be in fair to poor condition and requires corrective action.
- c. The abutment/toe area was not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.
- d. Tree(s) were observed along the abutment/toe. Trees have been identified as the probably cause of piping failures, and can possibly cause severe damage to the embankment if they are uprooted during a high winds. Corrective action is required to remove the tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2" diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of licensed geotechnical or structural engineer. Routinely monitor the damaged area for signs of settlement and seepage.
- e. Seepage/Ponding water was observed. Monitor and conduct further investigation to locate the source of water and extent of any possible hazardous or developing condition.
- f. It is recommended that a weir downstream of seep area on the left side be installed in a near by ditch to monitor seepage.

**I. Outlet Works: (Fair)**

Not inspected in detail, not tested.

Heavy vegetation should be removed and maintained low to enable easy visual inspection.

The outlet works appeared to be a tower structure with 3 gates that fed a 30" pipe. Two gates are operational and 1 is covered by sediment and is not operational.

The outlet works was controlled via gates on the upstream side of the dam.

Seepage was not observed flowing near the exit of the outlet works from the dam.

Findings and Corrective Actions:

- a. The outlet works were not tested.
- b. The outlet works appeared to be in fair to poor condition and requires corrective action.
- c. Were not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.
- d. Consideration may be given to installing another gate at a lower elevation to maintain better control of the reservoir level.
- e. Monitor outlet channel weir more often during higher pools.

**J. Spillway: (Poor)**

This spillway consisted of a channel, which is concrete lined to the crest and then earth on the downstream exit.

The rough dimensions were 180 ft long and 32 ft wide.

The spillway channel then feeds a drainage swale that runs along the left side of the downstream toe and then heads downstream.

The spillway approach is covered with trees and vegetation.

There was no erosion observed near the spillway.

The downstream vegetation appears to be bushes and woody vegetation. Further investigations should be conducted to conclude the capacity of the spillway.

Findings and Corrective Actions:

- a. The Spillway appeared to be in fair to poor condition and requires corrective action.
- b. Trees are unacceptable in the spillway channel and approach. Take corrective action to address the woody vegetation problem and repair the damaged area.
- c. Unclear if spillway is adequately sized. Spillway should pass the probable maximum flood. Verify spillway capacity and take corrective action as required.

**K. Down Stream Channel: (Unknown)**

The downstream channel was not investigated.

If the dam were to fail, the resulting flood wave would probably enter Nuuanu Stream.

There is a well-defined downstream channel.

This reservoir is considered to have a high hazard potential.

Findings and Corrective Actions:

- a. The downstream channel was not inspected.
- b. Remove vegetation and trees to facilitate inspection.

**XI. Additional Comments:**

Original field inspection notes were scanned and are attached to this summary report. Included are several photos from the site visit to detail important features of the project, captioned to be self-explanatory. All piezometers should be monitored more frequently during higher pools. Seepage area 2 beyond the toe is new since the pool is at this elevation. There has been increased seepage due to the high pool. All seepage should be monitored and its source determined. Reported by the site representative, this is highest level of the reservoir in the last 10 years.

Per e-mail dated 5/2/2006 5:16 am from Troy Cosgrove, USACE

Downstream Slope:

Please describe the access. i.e., lower roadway along toe, roadway to outlet work, walkway to outlet works or none observed. **The access to the outlet works was via a small walking path cut through the vegetation.**

Outlet works:

Please describe the tip of pipe, if known. **The type of pipe was DIP.**

Comments:

Please indicate if the dam presented a safety hazard at the time of inspection. Also please comment to the owner about the slope downstream slop stability. Should it be corrected immediately (within 6 months)? Would it be in their best interest to have a structural or geotechnical engineer assist them with the corrective action(s)? **The seepage that was present at the time of inspection needs to be further monitored and have the source identified. It did not present a safety hazard at the time of inspection, however further monitoring of the dam is warranted. The downstream slope stability needs to be investigated by a qualified geotechnical engineer and have recommendations made if corrections are needed.**

## PHOTOGRAPHS



Dam ID: OA-0001

Name: Nuuanu Dam No. 4



**Photo 1 Upstream slope and piezometers.**



**Photo 2 Upstream slope and spillway entrance.**



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**Photo 3 Weir on outlet channel.**



**Photo 4 Seepage area 3**



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**Photo 5 Seepage area 2.**



**Photo 6 New seepage in area 2.**



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**Photo 7 Spillway looking downstream.**



**Photo 8 Intake tower.**



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**Photo 9 Spillway entrance.**



**Photo 10 Low area in spillway.**



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**Photo 11 Base of spillway looking downstream.**



**Photo 12 Downstream slope, dense vegetation.**



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**Photo 13 Seep area 1.**



**Photo 14 Outlet pipe.**

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**Photo 15 Outlet pipe exiting embankment.**

## **FIELD INSPECTION SHEETS**

Dam ID: OA-0001  
NUUANU DAM NO. 4

Vulnerability Index:  
Extreme High Moderate Low  
1 2 3 4

Inspection No: \_\_\_\_\_  
Date: 4/3/06

STATE OF HAWAII - DLNR  
DAM SAFETY INSPECTION SHEET

Inspection Type: Visual Dam Safety Inspection

Persons Present

Affiliation

Phone Number

<u>Troy Cosgrove</u>	<u>US Army Corps of Engineers</u>	
<u>Doug Toews</u>	<u>NRCS</u>	
<u>Darrell Wong</u>	<u>Board of Water Supply</u>	
<u>Hiram Young</u>	<u>DLNR</u>	

Weather Condition: ☒ Rain previous day ☐ Rainy ☐ Drizzle / Mist ☐ Cloudy/Overcast ☐ Partly Cloudy ☒ Sunny ☐ Dry  
Comments: \_\_\_\_\_

1. General: (Information currently on file, update as required)

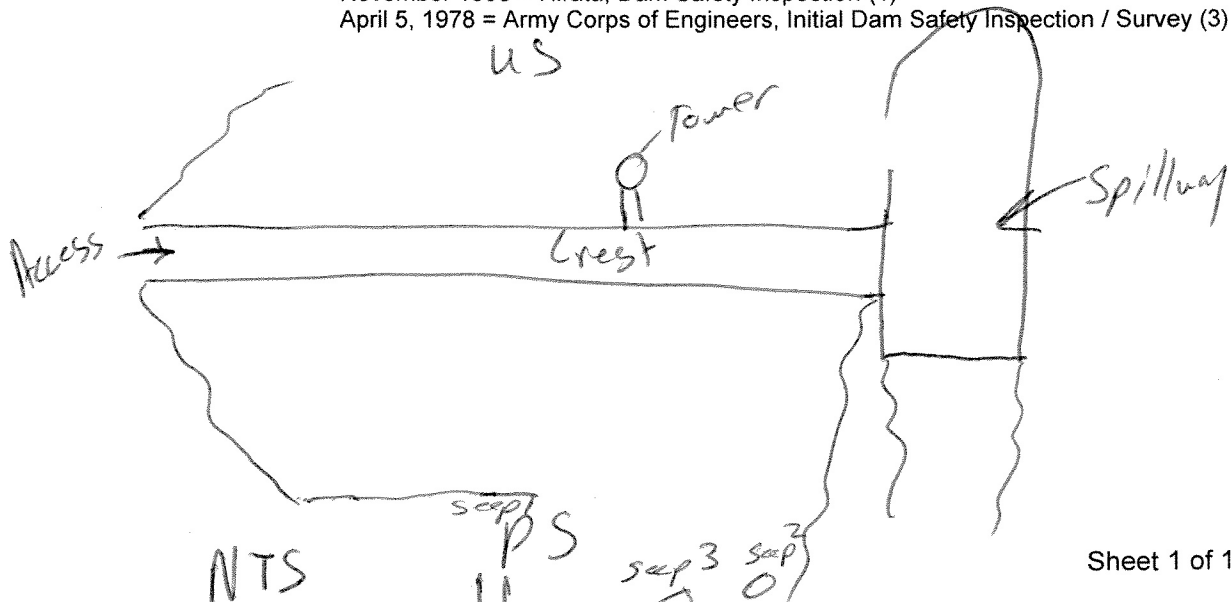
Dam/Res. Name	<u>NUUANU DAM NO. 4</u>		
Owner	<u>Honolulu Board of Water Supply</u> (C012)		
Owner Contact	<u>Mr. Chester Lao</u>	Owner Ph.	_____
Lessee	<u>N/A</u>	Lessee Ph.	_____
O & M Contractor	_____	O & M Ph.	_____
Nearest Town	<u>HONOLULU</u>	Latitude	<u>21.355 ° (decimal)</u>
County	<u>HONOLULU</u>	Longitude	<u>157.81 ° (decimal)</u>
Tax Map Key(s)	<u>(1)2-2-054:001</u>		

Dam Status	<u>A:</u>	Hazard Potential	<u>H:</u>	Dam Size	_____
Year Completed	<u>1910</u>	Dam Length	<u>1730 ft.</u>	Dam Height	<u>66 ft.</u>
Normal Storage	<u>242 ac.ft.</u>	Max. Storage	<u>3600 ac.ft.</u>	Max. Surface Area	<u>25 ac.</u>
Drainage Area	<u>2 mi.</u>	Spillway Type	<u>Unlined Channel</u>	Max. Spillway Q	<u>4000 cfs</u>

Owner owns land under dam facility: \_\_\_\_\_

Emergency Action Plan on file with the Department: YES

Reports on file with the Department: May 7, 1999 = Hirata, Phase II Study (DRAFT)  
November 1993 = Hirata, Dam Safety Inspection (1)  
April 5, 1978 = Army Corps of Engineers, Initial Dam Safety Inspection / Survey (3)





Dam ID: OA-0001

NUUANU DAM NO. 4

Inspection No: \_\_\_\_\_

Date: 4/3/06

**2. Questions for Owner's Rep.:**

	Yes	No	Unknown	Comments
Construction Plans Available	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Site / Facility Map	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Operation & Maintenance Manual	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Emergency Action Plan	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Modifications / Improvements	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Conduct Routine Inspections	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Reading Piezometers and Monitor Seepage every
Conduct Routine Maintenance	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Heavy Vegetation
Vehicle access to site	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Not accessible <input checked="" type="checkbox"/> With Standard car <input type="checkbox"/> Requires 4-Wheel Drive
Access during heavy rains	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Not accessible <input checked="" type="checkbox"/> With Standard car <input type="checkbox"/> Requires 4-Wheel Drive
Access when spillway is flowing	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Not accessible <input checked="" type="checkbox"/> With Standard car <input type="checkbox"/> Requires 4-Wheel Drive
Other Studies Conducted	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> Phase I <input checked="" type="checkbox"/> Phase II <input type="checkbox"/> Hydraulics <input type="checkbox"/> Stability <input type="checkbox"/> Hazard <input type="checkbox"/> Seismic
				<input type="checkbox"/> Other: _____
Incident History	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/> Breached <input type="checkbox"/> Overtop <input type="checkbox"/> Slide <input type="checkbox"/> Down stream Flooding
				<input type="checkbox"/> Other: _____
Reservoir's Current Use	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Sediment <input type="checkbox"/> Irrigation <input checked="" type="checkbox"/> Recreation <input checked="" type="checkbox"/> Flood Control <input type="checkbox"/> Drinking Water
				<input type="checkbox"/> Power Generation <input type="checkbox"/> Other: _____

**Findings and Corrective Actions:**

- ☒ a. The Owner shall maintain documentations including Construction plans, specifications, improvements, modifications, Operations and Maintenance Manuals and routine inspection logs for this dam facility.
- ☒ b. An Emergency Action Plan (EAP) is on file with the department, submit any updates as applicable.
- ☐ c. An EAP is required for High Hazard Dams. Submit an updated EAP for this facility.
- ☐ d. An EAP is recommended for all dams regardless of hazard class. Submit EAP if developed for the facility.
- ☐ e. Submit narrative and additional information detailing the improvements, modifications, and/or alterations at the dam site, unless covered by approved dam permit.
- ☒ f. Routine inspection logs were not inspected.
- ☒ g. Dam owners shall provide for routine inspection of the dam.
- ☒ h. The dam did not appear to be maintained on a regular basis.
- ☒ i. Access to site appears to be satisfactory.
- ☐ j. There is no vehicular access to the dam site. Operational and emergency plans need to reflect this deficiency or access provided.
- ☐ k. Access to dam is questionable during severe weather conditions and/or spillway overflows. Operational plans and emergency plans need to reflect this deficiency or access provided.
- ☒ l. Provide a detailed narrative of the incident, responses taken, and any damages incurred. Dam owners are required to promptly advise the department of any sudden or unprecedented flood or unusual or alarming circumstance or occurrences which may adversely affect the dam or reservoir.
- ☒ m. Submit current Operations and Maintenance Manual or Procedures for this dam / reservoir facility.
- ☒ n. Submit Site or Facility Map of this Dam which identifies the location of major features including outlet works controls and conduits.
- ☐ o. \_\_\_\_\_

**Additional Requirements:**

The following investigative study(s) are:

Required Recommended

- |                          |                          |  |
|--------------------------|--------------------------|--|
| <input type="checkbox"/> | <input type="checkbox"/> | Phase I Study  |
| <input type="checkbox"/> | <input type="checkbox"/> | Phase II Study (Including <input type="checkbox"/> Seepage <input type="checkbox"/> Hydrology/Hydraulics <input type="checkbox"/> EAP) |
| <input type="checkbox"/> | <input type="checkbox"/> | Hydrology and Hydraulics (including Probable Maximum Flood and spillway capacity)  |
| <input type="checkbox"/> | <input type="checkbox"/> | Stability Analysis   |
| <input type="checkbox"/> | <input type="checkbox"/> | Seismic Analysis   |
| <input type="checkbox"/> | <input type="checkbox"/> | Hazard Classification  |
| <input type="checkbox"/> | <input type="checkbox"/> | Other: _____   |

Dam ID: OA-0001

NUUANU DAM NO. 4

Inspection No: \_\_\_\_\_

Date: 4/3/06

**Physical Dam Features:** (Check All Applicable. Provide description of Items Observed and/or Take Photos. Indicate photo # in description.)

**3. Reservoir:**Level during inspection 40.7 ft per electric tape (gage / other)Normal Operating Level/Range 30 ft per electric tape (gage / other)Description: Normal level at 30ft relative to base of intake tower, 30ft  
Gate is lowest that is operationalTypical Operation ☐ Spillway always flowing ☒ Kept within normal range ☐ Kept Empty ☐ Drained Daily ☐ Only filled by Storms☐ Other: \_\_\_\_\_Sinkhole in Res.: ☐ # Observed: \_\_\_\_\_ Size: \_\_\_\_\_ by \_\_\_\_\_ in. Deep ☒ Not Visible ☒ None Observed

Description: \_\_\_\_\_

Staff Gage: Description: Stillling well in control tower with electric tape**Findings:**

- ☒ a. The reservoir was not inspected.
- ☐ b. The reservoir appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☐ c. The reservoir appeared to be in fair to poor condition and requires corrective action.
- ☐ d. The reservoir appeared to be in unsatisfactory condition, urgent corrective action is required.

**Corrective Actions:**

- ☐ e. The staff gage needs maintenance and/or repair. Description: \_\_\_\_\_
- ☒ f. A staff gage was not observed at the reservoir. Provide some method of quantifying the water level within the reservoir. As backup to electric tape
- ☐ g. A sinkhole was observed in the upstream reservoir. Conduct additional investigations and monitoring to identify the cause, risk and appropriate action.

TC ☒ h. As

**4. Intake Works Description:**Surface runoff, no intakes noted☐ Number of Intakes \_\_\_\_\_☐ Intake Culvert / PipeSize: \_\_\_\_\_ in. ☐ DIP ☐ Corrugated Metal ☐ PVC ☐ HDPE ☐ Concrete ☐ Other \_\_\_\_\_Control: ☐ Gate ☐ Valve ☐ Flow can either be Shut off or BypassedFrom: ☐ Stream Diversion ☐ Pump ☐ Reservoir ☐ Other \_\_\_\_\_☐ Ditch / Flume

Dimension: \_\_\_\_\_ (Size x Depth) Shape \_\_\_\_\_

Surface: ☐ Dirt ☐ Wood ☐ Concrete ☐ Lined w/ \_\_\_\_\_Control: ☐ Gate ☐ Valve ☐ Flow can either be Shut off or BypassedFrom: ☐ Stream Diversion ☐ Pump ☐ Reservoir ☐ Other \_\_\_\_\_**Findings:**

- ☐ a. The intake works were not inspected.
- ☐ b. The intake works were not tested.
- ☐ c. The intake works appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☐ d. The intake works appeared to be in fair to poor condition and requires corrective action.
- ☐ e. The intake works appeared to be in unsatisfactory condition, urgent corrective action is required.

**Corrective Actions:**

- ☐ f. The intake works needs maintenance and/or repair. Description: \_\_\_\_\_
- ☐ g. \_\_\_\_\_

Dam ID: OA-0001

NUUANU DAM NO. 4

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Date: 4/3/06

### 5. Upstream Slope:

(Typical Slope ± 1V : 2H TFC)

Slope Protection: ☐ None ☐ Dumped Rock ☒ Fitted Rip Rap ☐ Grouted Rip Rap ☐ Liner ☐ Other: \_\_\_\_\_

☒ Defect in Protection: Description: Heavy vegetation and trees

Erosion: ☐ Loose soil w/ little vegetation ☐ Rut (<6") ☐ Gully (>6" deep) ☒ Not Visible ☐ None Observed

Description: Heavy vegetation and trees

Cracks: ☐ Parallel with crest ☐ Perpendicular to crest ☐ Slide visible ☒ Not Visible ☐ None Observed

Description: Heavy vegetation and trees

Sinkholes: ☐ # Observed: \_\_\_\_\_ Size: \_\_\_\_\_ and \_\_\_\_\_ Depth ☒ Not Visible ☐ None Observed

Description: Heavy vegetation and trees

Vegetation: ☐ None ☐ Low Ground Cover ☒ Bushes or Tall Grass ☒ Trees # many ☒ <6" ☐ >6" & <20" ☐ >20"

Description: Slope not maintained, heavy vegetation and trees

### Findings:

- ☒ a. The upstream slope was not inspected.
- ☐ b. The upstream slope appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☐ c. The upstream slope appeared to be in fair to poor condition and requires corrective action.
- ☐ d. The upstream slope appeared to be in unsatisfactory condition and not expected to fulfill its intended function. Urgent corrective action is required.

### Corrective Actions:

- ☐ e. Slope protection needs maintenance or repair. Description: \_\_\_\_\_
- ☐ f. Rut and/or Gully erosion was observed on the slope, which requires maintenance and/or repair. Description: \_\_\_\_\_
- ☐ g. A crack was observed on the slope, which requires further investigation to determine the underlining cause. Monitor the area and/or repair as required.
- ☐ h. A sinkhole was observed on the slope, which requires further investigation to determine the underlining cause. Repair and monitor the area.
- ☒ i. The upstream slope was not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.
- ☒ j. Tree(s) were observed on the dam embankment. Trees have been identified as the probably cause of piping failures, and can possibly cause sever damage to the embankment if they are uprooted during a high winds. Corrective action is required to remove the tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2" diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of licensed geotechnical or structural engineer. Routinely monitor the damaged area for signs of settlement and seepage.
- ☒ k. Monitor piezometers at a higher frequency during higher pools.  
Downstream

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**6. Crest:**

Approximate Crest Width: 20ft

Access: ☐ None ☐ Walking Path ☒ Roadway, Surface / Width / Usage: Site Access

Erosion: ☐ Loose soil w/ little vegetation ☐ Rut (<6") ☐ Gully (>6" deep) ☐ Not Visible ☒ None Observed

Description: \_\_\_\_\_

Cracks: ☐ Parallel with crest ☐ Perpendicular to crest ☐ Slide visible ☐ Not Visible ☒ None Observed

Description: \_\_\_\_\_

Sinkholes: ☐ \_\_\_\_\_ in. Wide x \_\_\_\_\_ in. Long x \_\_\_\_\_ in. Deep ☐ Not Visible ☒ None Observed

Description: \_\_\_\_\_

Vegetation: ☐ None ☐ Low Ground Cover ☒ Bushes or Tall Grass ☒ Trees # many ☒ <6" ☒ >6" & <20" ☒ >20"

Description: Vegetation and trees on edges of crest

**Findings:**

- ☐ a. The dam crest was not inspected.
- ☐ b. The dam crest appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☒ c. The dam crest appeared to be in fair to poor condition and requires corrective action.
- ☐ d. The dam crest appeared to be in unsatisfactory condition and not expected to fulfill its intended function. Urgent corrective action is required.

**Corrective Actions:**

- ☒ e. Access along the crest was satisfactory.
- ☐ f. Access along the crest was not possible. Description: \_\_\_\_\_
- ☐ g. Rut and/or Gully erosion was observed on the crest, which requires maintenance and/or repair. Description: \_\_\_\_\_
- ☐ h. A crack was observed on the crest, which requires further investigation to determine the underlining cause. Monitor the area and/or repair as required.
- ☐ i. A sinkhole was observed on the crest, which requires further investigation to determine the underlining cause. Repair and monitor the area.
- ☒ j. Portions of the crest were not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.
- ☒ k. Tree(s) were observed along the dam crest. Trees have been identified as the probably cause of piping failures, and can possibly cause sever damage to the embankment if they are uprooted during a high winds. Corrective action is required to remove the tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2" diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of licensed geotechnical or structural engineer. Routinely monitor the damaged area for signs of settlement and seepage.
- ☐ l. \_\_\_\_\_

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## 7. Downstream Slope:

(Typical Slope  $\pm$  1V : 2H)

Access: ☐ lower roadway along toe ☐ roadway to outlet works ☐ walkway to outlet works ☐ None Observed

Slope Protection: ☐ None ☐ Dumped Rock ☒ Rip Rap ☐ Grouted Rip Rap ☐ Concrete

Erosion: ☐ Loose soil w/ little vegetation ☐ Rut (<6") ☐ Gully (>6" deep) ☒ Not Visible ☐ None Observed

Description: Heavy vegetation and trees

Cracks: ☐ Parallel with crest ☐ Perpendicular to crest ☐ Slide visible ☒ Not Visible ☐ None Observed

Description: Heavy vegetation and trees

Sinkholes: ☐ \_\_\_\_\_ in. Wide x \_\_\_\_\_ in. Long x \_\_\_\_\_ in. Deep ☒ Not Visible ☐ None Observed

Description: Heavy vegetation and trees

Vegetation: ☐ None ☐ Low Ground Cover ☒ Bushes or Tall Grass ☒ Trees # many ☐ <6" ☐ >6" & <20" ☐ >20"

Description: Slope not maintained, heavy vegetation and trees

Seepage: Seep Spot Number 1

☐ Green Vegetation ☐ Wet or Muddy Ground ☐ Ponding Water ☒ Not Visible ☐ None Observed

☐ Flowing, Description: Very Heavy vegetation and trees

Water Clarity: ☐ Clear ☐ Some particles ☐ Muddy ☐ Other: \_\_\_\_\_

Description: \_\_\_\_\_

Seep Spot Number 2

☐ Green Vegetation ☐ Wet or Muddy Ground ☐ Ponding Water ☐ Not Visible ☐ None Observed

☐ Flowing, Description: \_\_\_\_\_

Water Clarity: ☐ Clear ☐ Some particles ☐ Muddy ☐ Other: \_\_\_\_\_

Description: \_\_\_\_\_

## Findings:

- ☐ a. The downstream slope was not inspected.
- ☐ b. The downstream slope appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☒ c. The downstream slope appeared to be in fair to poor condition and requires corrective action.
- ☐ d. The downstream slope appeared to be in unsatisfactory condition and not expected to fulfill its intended function. Urgent corrective action is required.

## Corrective Actions:

- ☐ e. Slope protection needs maintenance or repair. Description: \_\_\_\_\_
- ☐ f. Rut and/or Gully erosion was observed on the slope, which requires maintenance and/or repair. Description: \_\_\_\_\_
- ☐ g. A crack was observed on the slope, which requires further investigation to determine the underlining cause. Monitor the area and/or repair as required.
- ☐ h. A sinkhole was observed on the slope, which requires further investigation to determine the underlining cause. Repair and monitor the area.
- ☒ i. The down stream slope was not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.
- ☒ g. Tree(s) were observed on the downstream slope. Trees have been identified as the probably cause of piping failures, and can possibly cause sever damage to the embankment if they are uprooted during a high winds. Corrective action is required to remove the tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2" diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of licensed geotechnical or structural engineer. Routinely monitor the damaged area for signs of settlement and seepage.
- ☐ h. Seepage/Ponding water was observed. Monitor and conduct further investigation to locate the source of water and extent of any possible hazardous or developing condition.
- ☐ i. Seepage was observed flowing and particles were observed to be removed by the flow. Take immediate action to stop the loss of soil from the embankment. Conduct further investigation to determine the underlining cause and take corrective action. Monitor the area.
- ☐ j. The slope was very steep, around a 1 to 1 slope, further study is required to verify slope stability.
- ☒ k. Near toe of slope the DS slope steepens to 1:1, maybe stability berm, further study maybe required to verify slope stability.

### 8. Abutments/Toe:

Erosion: ☐ Loose soil w/ little vegetation ☐ Rut (<6") ☐ Gully (>6" deep) ☒ Not Visible ☐ None Observed  
Description: Heavy vegetation and trees

Cracks: ☐ Parallel with crest ☐ Perpendicular to crest ☐ Slide visible ☒ Not Visible ☐ None Observed  
Description: Heavy vegetation and trees

Vegetation: ☐ None ☐ Low Ground Cover ☒ Bushes or Tall Grass ☒ Trees # many ☒ <6" ☒ >6" & <20" ☒ >20"  
Description: Toe not maintained, heavy vegetation and trees

Seepage: Seep Spot Number 1  
☐ Green Vegetation ☐ Wet or Muddy Ground ☒ Ponding Water ☐ Not Visible ☐ None Observed  
☒ Flowing, Description: Small flow, trace  
Water Clarity: ☒ Clear ☐ Some particles ☐ Muddy ☒ Other: \_\_\_\_\_  
Description: Iron stained near seepage area, at base of toe berm left of DS Piezometers

Seep Spot Number 2 + 3  
☐ Green Vegetation ☒ Wet or Muddy Ground ☒ Ponding Water ☐ Not Visible ☐ None Observed  
☒ Flowing, Description: New seepage detected at seepage area 2  
Water Clarity: ☒ Clear ☐ Some particles ☐ Muddy ☐ Other: \_\_\_\_\_  
Description: Iron stained

### Findings:

- Seep 2 DS left side Seep 3 DS left side closed to outlet channel
- ☒ a. The abutments/toe were not inspected. (not fully inspected due to vegetation)
  - ☐ b. The abutments/toe appeared to be in satisfactory condition, no corrective actions are required at this time.
  - ☒ c. The abutments/toe appeared to be in fair to poor condition and requires corrective action.
  - ☐ d. The abutments/toe appeared to be in unsatisfactory condition and not expected to fulfill its intended function. Urgent corrective action is required.

### Corrective Actions:

- ☐ e. Slope protection needs maintenance or repair. Description: \_\_\_\_\_
- ☐ f. Rut and/or Gully erosion was observed, which requires maintenance and/or repair. Description: \_\_\_\_\_
- ☐ g. A crack was observed along the abutments/near the toe, which requires further investigation to determine the underlining cause. Monitor the area and/or repair as required.
- ☒ h. The abutment/toe area was not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.
- ☒ i. Tree(s) were observed along the abutment/toe. Trees have been identified as the probably cause of piping failures, and can possibly cause sever damage to the embankment if they are uprooted during a high winds. Corrective action is required to remove the tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2" diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of licensed geotechnical or structural engineer. Routinely monitor the damaged area for signs of settlement and seepage.
- ☒ j. Seepage/Ponding water was observed. Monitor and conduct further investigation to locate the source of water and extent of any possible hazardous or developing condition.
- ☐ k. Seepage was observed flowing and particles were observed to be removed by the flow. Take immediate action to stop the loss of soil from the embankment. Conduct further investigation to determine the underlining cause and take corrective action. Monitor the area.
- ☒ l. Install weir down from <sup>area</sup> Seep 2 in ditch to monitor seepage

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### 9. Outlet Works:

Culvert / Pipe

Type / Size: Tower structure 3 gates feed 2 30 in pipe outlet

Culvert: ☐ Concrete ☐ Masonry ☐ unlined earth ☐ Other \_\_\_\_\_

Pipe: ☐ DIP ☐ Corrugated Metal ☐ PVC ☐ HDPE ☐ Concrete ☐ Other \_\_\_\_\_

Control Type: ☒ Gate ☐ Valve ☐ Other 2 operational; one covered by sediment and not operation

Location: ☒ Control on Upstream side ☐ Control on Downstream side

Seepage: ☐ Green Vegetation ☐ Wet or Muddy Ground ☐ Ponding Water ☒ Not Visible ☐ None Observed

☐ Flowing, Description: \_\_\_\_\_

Water Clarity: ☐ Clear ☐ Some particles ☐ Muddy ☐ Other: \_\_\_\_\_

Description: \_\_\_\_\_

#### Findings:

- ☐ a. The outlet works were not inspected.
- ☒ b. The outlet works were not tested.
- ☐ c. The outlet works appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☒ d. The outlet works appeared to be in fair to poor condition and requires corrective action.
- ☐ e. The outlet works appeared to be in unsatisfactory condition and not expected to fulfill its intended function. Urgent corrective action is required.

#### Corrective Actions:

- ☐ f. Seepage/Ponding water was observed. Conduct further investigation to locate the source of water and extent of any possible hazardous or developing condition.
- ☐ g. Seepage was observed flowing and particles were observed to be removed by the flow. Take immediate action to stop the loss of soil. Conduct further investigation to determine the underlining cause and take corrective action. Monitor the area. Failures caused by seepage/piping along the outlet conduit are very common and are considered to be a dangerous situation.
- ☒ h. Were not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.
- ☒ i. Consideration may be given to installing another gate at a higher elevation to maintain better control of reservoir level.
- ☒ j. Monitor outlet channel weir more often during higher pools

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## 10. Spillway:

Type:

☐ None ☐ Culvert/Pipe ☒ Channel

Description: concrete lined to crest then earthen channel

Dimension: 30 ft. Invert elevation: not known ft. per staff gage

Slope Protection: ☐ None ☐ Grass ☐ Dumped Rock ☐ Fitted Rip Rap ☐ Grouted Rip Rap ☒ Concrete

☐ Defect in Protection: Description: \_\_\_\_\_

Approach: ☐ Clear ☒ High Veg. ☒ Trees ☐ Other: \_\_\_\_\_

Erosion: ☐ Scour ☐ Gully ☐ Headcut ☒ Not Observed ☐ Other: \_\_\_\_\_

Description: \_\_\_\_\_

Vegetation: ☒ None ☒ Low Ground Cover ☐ Bushes or Tall Grass ☐ Trees # \_\_\_\_\_ ☐ <6" ☐ >6" & <20" ☐ >20"

Description: None on concrete portion then, some low ground cover on earthen part

### Findings:

- ☐ a. The Spillway appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☒ b. The Spillway appeared to be in fair to poor condition and requires corrective action.
- ☐ c. The Spillway appeared to be in unsatisfactory condition and not expected to fulfill its intended function. Urgent corrective action is required.

### Corrective Actions:

- ☐ d. Slope protection needs maintenance or repair. Description: \_\_\_\_\_
- ☐ e. The spillway approach was blocked. Clear approach.
- ☐ f. Severe scour erosion was observed which requires maintenance and/or repair.  
Description: \_\_\_\_\_
- ☐ g. A headcut (vertical drop in channel due to erosion) was observed downstream of the spillway. Corrective action is required to prevent this problem from moving upstream.
- ☒ h. Trees are unacceptable in the spillway channel and approach. Take corrective action to address the woody vegetation problem and repair the damaged area.
- ☐ i. Unclear if spillway is adequately sized. Spillway should pass the probable maximum flood. Verify spillway capacity and take corrective action as required.
- ☐ j. \_\_\_\_\_

## 11. Down Stream Channel:

Name: Nuuanu Stream

Downstream: ☐ Sump ☐ Open Area ☐ Un-Defined Drainage-way ☒ Defined Drainage-way ☐ Other \_\_\_\_\_

Items along Stream Bank: ☒ None ☐ Road ☐ Houses ☐ Town ☒ Not Inspected

Description: \_\_\_\_\_

### Findings:

- ☒ a. The downstream channel was not inspected.
- ☐ b. The downstream channel appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☐ c. The downstream channel appeared to be in fair to poor condition and requires corrective action.
- ☐ d. The downstream channel appeared to be in unsatisfactory condition and not expected to fulfill its intended function. Urgent corrective action is required.

### Corrective Actions:

- ☒ e. Remove vegetation and trees to facilitate inspection.



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**Additional Comments:**

On the date of this limited visual inspection, there appeared to be no immediate threat to the safety of the dam. No assurance can be made regarding the dam's condition after this date. Subsequent adverse weather and other factors may affect the dam's condition.

Downstream piezometers should be read more frequently during higher pools.

Seepage area 2 at toe (actually beyond toe) is new since the pool is at this elevation. There has been increased seepage due to the high pool. This and all seepage should be monitored and its source determined.

Reported by site representative that this level of reservoir highest in last 10yrs.

**Limitations and Intent of this Dam Safety Inspection:**

This Dam Safety Inspection was conducted to assess the general overall condition of the reservoir/dam, identify visible deficiencies, and recommend areas of for monitoring, additional investigative studies and corrective actions. The inspection is based only on visible features/areas of the dam on the day of inspection. This inspection is not a formal phase I or phase II dam safety inspection and does not include a review or evaluation from each specialist of an inspection team, such as a geologists, civil, geotechnical, structural, or hydraulics engineer. The owner should verify the findings of this report and take corrective actions. The owner may submit to the State alternative corrective actions that are certified by a licensed professional engineer in the State of Hawaii experienced in the design and construction of dams. This inspection does not relieve the owner/operator from their responsibility to conduct routine inspections, maintenance, repairs, modifications, monitoring, documentation, and/or investigative studies. The inspection was conducted under the authority of the Hawaii Revised Statutes Chapter 179D, and Hawaii Administrative Rules, Title 13, Chapter 190, titled "Dams and Reservoirs". Questions regarding this inspection should be forwarded to the Hawaii State Dam Safety Program; PO Box 373; Honolulu, Hawaii 96809; Ph. (808) 587-0236.

Revised: Dec. 1, 2003